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Meeting abstract

110 Myofiber developmental plasticity in fetal hearts delineated with diffusion tensor MRI

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Introduction

Myocardial fiber structure is a critical determinant of cardiac function. Previous studies have shown that the right ventricle workload is greater in the gestational period than that after birth. We hypothesized that myofiber structure in developing heart would differ from that of the adult heart. The objective of this study was to quantify myocardial fiber structure in fetal pig hearts at 60 day gestation period, which is equivalent to 150 days in human, with the use of diffusion tensor MRI (DTI) and to compare that with our previous result in adult hearts.

Materials and methods

Fetal pigs (n = 6) at 60 day gestation period preserved in formalin were purchased from Nebraska Scientific, Omaha, NE. Hearts were excised and fixed in 10% formalin solution. Before MR scanning, each heart was rinsed by phosphate buffered saline (PBS) and kept in PBS for 24 hours. DTI of fetal pig heart was performed on an 11.74 T Varian INOVA MR system using a 3 cm birdcage coil. Diffusion tensor images were acquired using a multi-slice diffusion-weighted spin-echo pulse sequence with the following parameters: TR, 2 s; TE, 33 ms; δ, 5 ms, Δ, 20 ms; b-value, 0 and 1063 s/mm^2; direction of applied diffusion-weighting gradients, 7; slice thickness, 0.5 mm; and in-plane resolution, 156 × 156 μm. Myofiber orientation in each voxel was estimated as the direction exhibiting maximal apparent diffusion coefficient of water. Reconstructed myofiber orientations were projected onto the short-axis plane of the heart to illustrate the orientations of myocardial fibers. These measured fiber orientations were compared with our previous analogous results in adult rat hearts to characterize the difference in myofiber structures between fetal and adult hearts (n = 11).

Results

Figure 1 shows the diffusion tensor images of fetal heart and matured heart in the short-axis plane of the hearts. The fetal pig heart at 60 day gestation period exhibits well balanced fiber distribution between left and right ventricle as illustrated in Fig. 1a. While, Fig. 1b shows a representative fiber orientation map of an adult heart, in which most fibers contributed to the left ventricle rather than the right ventricle. Comparison between myofiber orientation maps (Fig. 2a and Fig. 2b) further confirms that although fiber structures in left ventricular free wall (LVFW) were similar between fetal and adult hearts, in septum, myofiber arrangements between the two were different. The majority of myofibers in adult heart septum (Fig. 2b) tracked to the LVFW. In contrast, myofibers in the septum of fetal heart (Fig. 2a) tracked to both LVFW and right ventricular free walls (RVFW).

Conclusion

Myocardial fiber structure in fetal hearts differed from that in adult hearts and reflected a balanced contribution to both the left ventricle and the right ventricle. After maturation, these fibers tracked almost exclusively to the left ventricle and lost their contribution to right ventricular architecture. These marked structural rearrangements

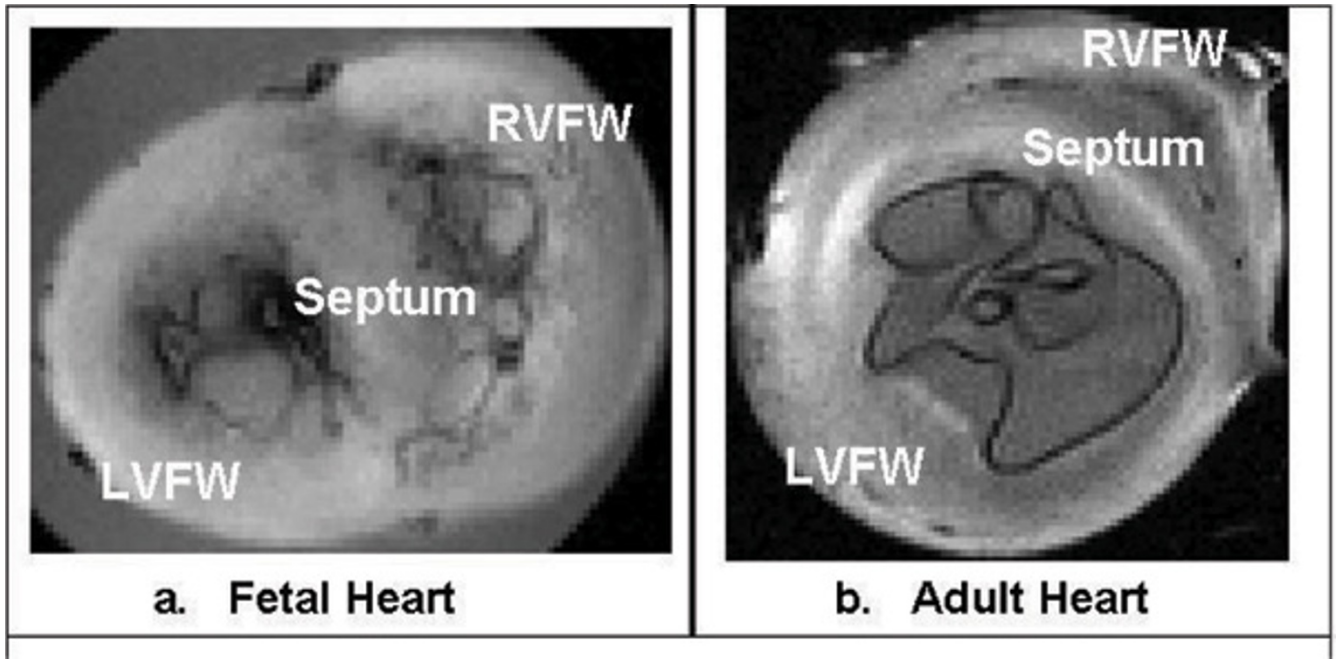

Figure 1
Diffusion tensor image in short-axis plane.

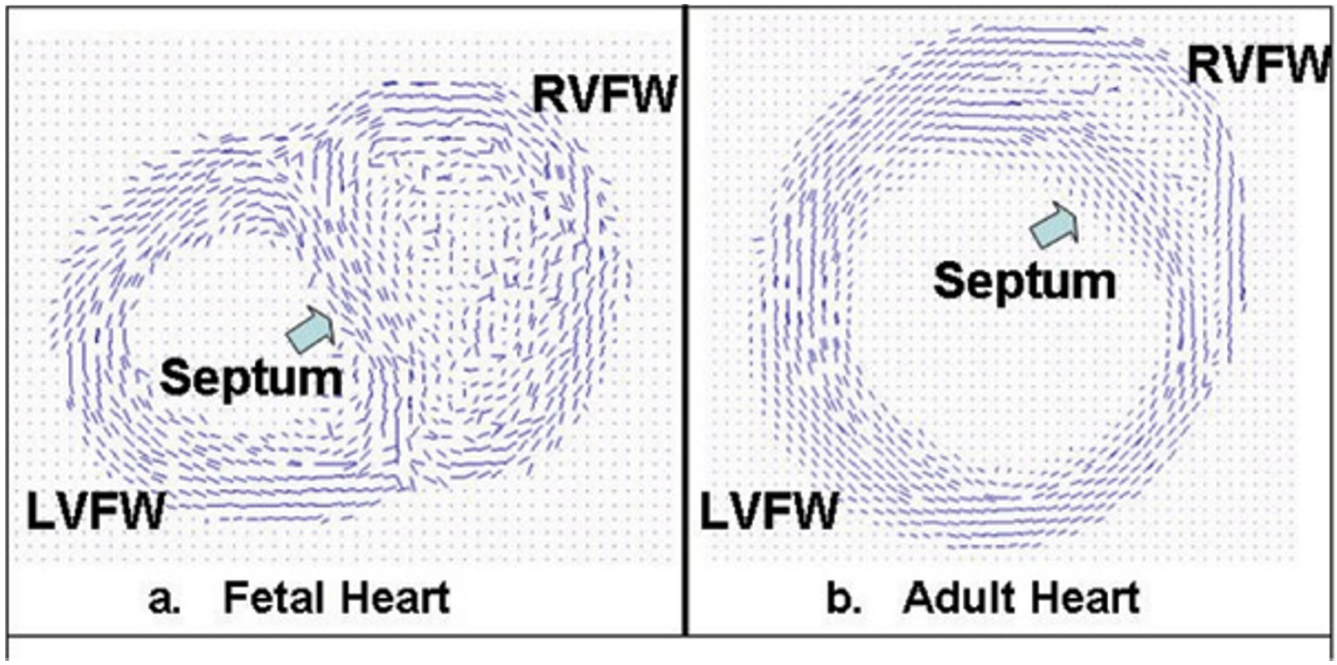

Figure 2
Myofiber orientation map on short-axis plane. Myofiber structure in fetal hearts is different from that in adult hearts. Balanced contribution of septal myofibers from both ventricles of fetal heart was observed, suggesting plasticity of myofiber development in response to different contractile function before and after birth.

reflect the plasticity of myocardial fiber development in response to programmed alterations in contractile function that occur after birth.